OBSERVATIONS OF THE CHANGING VEGETATION OF CAMEL'S HUMP, VERMONT, IN RELATION TO ACID DEPOSITION*

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Key Words: Camel's Hump, Vermont; Acid Deposition; Vegetation Zones

PURPOSES OF THE STUDY. The objectives of this investigation were fourfold: to make a preliminary study of the composition, structure and general nature of the Vegetation Belts and Zones of Camel's Hump (summit at 4083 feet); to interpret in the light of present knowledge, the effects of acid precipitation on these forests; to make a highway reconnaissance of these same Vegetation Zones elsewhere in central and southern Vermont, looking for obvious effects of acid precipitation; to comment upon some of the pertinent literature; and then to integrate these four approaches into a single whole that is the acid deposition environmental problem.

ACKNOWLEDGEMENTS. I am deeply obligated to John M. Huckabee and Robert Goldstein whom I accompanied on their field study on Camel's Hump July 17, 1984, benefiting from their observations and discussions, and with later comments on the manuscript. I am also deeply obligated to Hubert W. Vogelmann, whom I accompanied up the Hump on June 4, 1984, with following discussions and later comments on the manuscript; and who gave me the fullest possible benefits of the wealth of his knowledge, viewpoints, ongoing research and future plans.

Above all, I am indebted to John P. Anderson, Jr., who accompanied me on this field work, not as an assistant but as a co-scientist. We have had endless, subsequent discussions. His powers of field observation, his keenness of interpretation, his role as a devil's advocate, all more than entitle him to be co-author of this paper -- a role he modestly but persistantly declines.

CONCEPTS OF ECOSYSTEM SCIENCE vs. ECOSYSTEM ANALYSIS. One of the sociologic megatrends in the ecology of the 1980's is evidenced in the pages of every issue of Ecology: a hyper-development of "applied mathematics", a devotion to "numeracy" that will fascinate the historians of the future. The corollary of these trends is the neglect of "literacy", of the verbally descriptive. Photographs of vegetation and animals for example, have all but vanished. Along with this trend is the methodologic emphasis on intensive laboratory analysis of parts, chosen by sampling (with all the limitations of such inferential reasoning) versus the methodologic neglect of extensive study of wholes. A superb discussion of this problem has just appeared in BioScience (III 85:165-171),"Limitations of Laboratory Bioassays. The Need for Ecosystem-Level Testing" by Kenneth D.

*The author acknowledges the financial assistance of the Electric Power Research Institute, Palo Alto, Cal. 94303, in effecting this field study

Kimball and Simon A. Levin). This paper is essentially a rediscovery of the holism of the 1920s, first applied to Vegetation in the 1940s.

The problem is directly applicable to the crisis of acid precipitation effects in Vegetation. All the super-expensive research is concentrated on the study of "parts", of pH, S, N, Al and other metals, et al. The Reagan administration and industry insist on "proof" that S be the principal culprit before taking any action, which "proof" of course no parts-scientists can ever claim. Here is a formula for doing nothing. Environmentalists and whole-scientists know full well that sulfur emissions are irrefragably a significant contribution to acid and environmental pollution. No more research is needed to demonstrate concern, and to take action. Unfortunately, too many whole-scientists (in a field now sadly neglected) try to extrapolate from their parts-data to whole-pronouncements, in ways that leave them wide-open to maceration by the opposition.

THE CONCEPTS OF ZONES AND BELTS. Vegetation "areas" have long been recognized in the study of plant-communities, especially those of mountainous regions. This interest goes back to the days of descriptive "phytogeography" of the late 19th century. Such areas, as seen in every aerial photograph, have been merely "cover types", areas of uniform "physiognomy" with respect to existing desert, scrubland, grassland, hardwood forest or conifer forest, not necessarily involving past, future or possible Vegetation. The term Zone is here used in the sense of Bray (1915) for New York State, and of Egler (1940) for western Massachusetts. Connecticut was first so zoned by Egler and Niering in 1965, and the Zones have been used in several subsequent publications of theirs. They are holistic concepts,(embracing areas and temporal relationships past, present, natural future, and possible future) of importance to the basic and applied sciences, to foresters, wildlifers and agriculturists. As yet, these important zones have not been mapped in detail for Vermont, and their absence greatly limits the extrapolation that scientists may attempt from their local and minutial studies.

Belts have been used in a minor and subsidiary sense (as between the fir Krummholz and the upper Fir Forest), for conspicuously different types which may nevertheless be closely related. In other publications I have personally used the term "Belts" for the Upper Slope, Mid-Slope, Lower Slope, Wetland segregation, universally observable in the local topography (i.e.,within altitudinal ranges of several hundred feet).

On the other hand, where large mountain ranges occur (as the Green Mts. of Vermont) the Upper Slope of one Zone may be surmounted by the Upper Slope of the next higher (colder) Zone, thus producing holistic complexities for which scientific judgment is sorely needed, and ecolometric sampling can be dangerously illogical.

Seven days were spent in the field by both Frank E. Egler and John P. Anderson, Jr. Four days (June 3, 6, and July 16, 18, 1984) were spent in a highway survey to verify the existence of these Zones, and their extension from adjacent New York, Massachusetts, and Connecticut, in the light of past unpublished observations from New Hampshire and Maine. Notes were taken on the occurrence and abundance of certain "indicator species" such as Balsam Fir, Red Spruce, Hemlock, oaks, hickories, Sassafras, Cottonwood, and Pitch Pine. Observations were made on the general Mid-Slope forests, on the rocky outcrops both at the summits of the hills and on the slopes below, on old pastures, on shrubs invading pastures, and on conspicuous roadside species.

Three days (June 4, 5, and July 16, 1984) were spent on the Trail up the west side of Camel's Hump, from the end of the Town Road out of Huntington Center, to the summit of Camel's Hump, all in Camel's Hump State Forest. Field notes were taken at intervals on the changing composition and abundances of the vegetationally important species. (Sample plots for the taking of quantitative data were not established, partly because such research is being done by others.) Situations and characteristics were searched for that are likely to be overlooked in the ecolometric sampling methods that have dominated the local research.

The U.S. Geol. Surv. topographic map, Huntington Quad. 7½ min. series, is extremely valuable for revealing important features of the landscape, especially along the unnamed heavily used foot-trail (called "transect" in the scientific literature), such as the brook-crossing at 2360 ft., the "break in topography" at 3060 ft., the wind saddle at 3825 ft., and the exposed summit at 4083 ft. The entire mountain is called Camel's Hump (spelled without an apostrophe on the map -- apparently a typographic error, dutifully followed subsequently in all the literature). Curiously, no copy of the topographic map has appeared in any acid precipitation scientific papers, perhaps because its informative complexity is irrelevant to the dogmatic methodology of sampling a transect for Whittaker's "Direct Gradient Analysis". This method assumes and assures that the actual elevation of the sampled "stands" (translated into rounded meters, without also giving the original readings in feet, which are 200 foot elevations) is the quantified correlate of prime ecolometric importance (as if it were a perfect Fujiyama-like cone) by means of which the Vegetation of the mountain can be analyzed and understood. Pure altitudinal determination. (In marked methodologic contrast, one should examine the excellent study by Foster and Reiners 1984 (Bull. Torrey Bot. Club 110(2):141-153) where they consider many kinds of "patches" in the complex topography of the unlumbered forest at Crawford Notch, White Mts., New Hampshire.)

I. The Taiga Vegetation Zones and Belts

The Taiga (originally a Siberian term for the extensive northern forest: the Black Taiga of spruce and fir, and the White Taiga of aspen and birch) is here used for all comparable North American forests dominated by species of the Northeastern Great Lakes - St. Lawrence Valley "center of distribution" as used by Transeau in 1905, and its close analogues in the Southern Appalachians, the Cascades and the Pacific Northwest. Thus, these Zones are only locally "boreal" or "montane". The summits of the highest mountains of the Adirondacks (N.Y.), the Green Mountains (Vermont), the White Mountains (New Hampshire) and Mt. Marcy (Maine) are physiognomically and floristically distinctive areas of rocks, lichens, herbs and low shrubs. Unquestionably some of these taxa are disjunct bits of true Tundra, with species that are not found in the lower-elevation low-altitude forests predominantly of spruce and fir. On the other hand, the summit of Camel's Hump, tho above the Krummholz, does not in our opinion have a sufficient number of predominant Tundra species to be so classified (even tho signs and guides tell the hiker that this area is "fragile alpine Tundra". It is fragile in the sense that hiking boots could and do easily destroy the layer of thick organic peat that tends to extend out and cover the rocks. Human overuse of this area must be carefully monitored.

The Summit Belt. This ca. 10-acre cap-like area (which has not been the subject of a detailed botanical study), bare even of low firs, and rising above all nearby mountains, is superb in its views of the surrounding terrain, both for the hiker and the scientist. Over half the surface is bare bedrock, rounded and smoothed by glacial action. Rhizocarpon geographicum is a bright yellow-fruiting lichen that provides an "aspect" to the site. Apparently Rhizocarpon is relatively resistant to the boots of hikers, as yet. Between rocks, and tending to form an advancing (or receding) mat upon them, is an organic layer of peat, to ten inches in depth, bearing a solid turf of Carex. Conspicuous in July are flowering patches of Arenaria groenlandica var. groenlandica. (But whether this is only a summit-stunted form of the taller Arenaria groenlandica var. glabra, known from rocky outcrops at much lower elevations and latitudes, cannot be told without transplant research). Potentilla tridentata is another Tundra-suspect (but that is also found on the rocky summits of the Taconics in southwestern Massachusetts, along with the much more "southern" Pitch Pine and Scrub Oak.) An ericaceous shrub forming a solid mat less than ten inches high, is characteristic of the deeper peat mats. There is no obvious evidence of acid rain deterioration on this summit, apparent to the naked eye.

The Krummholz Fir Belt. In a circular belt around the stony summit, occupying a vertical habitat of about 100 feet of elevation (and probably not more than 20 acres in extent) is a picturesque Vegetation of a physiognomic type known the world over. (The Krumm-

holz was not part of Siccama's 1974 forest study, and has not been separately considered in the Camel's Hump Univ. of Vt. project). Firs are the major woody plant (fruiting heavily in 1984), gnarled and twisted, seemingly in relation to severe exposure in winter. Mountain Ash, Paper Birch (two deciduous hardwood, note), an occasional Spruce (with no kill-back) and other woody and herbaceous plants of the fir forest below, are found, indicating the close relationship of this Belt to the fir forest, and implying that the Krummholz is to be considered an "emergence into dominance" and into growth-forms of those species that can tolerate the extremely unfavorable environment of these places, involving high winds, high insolation, drouth, and thin rocky highly-acid organic soil. There is no evidence of marked alteration in the altitudinal level of this belt during the last several centuries, such as has been reported in the literature in parts of western North America.

There was (in 1984) no sign of unusual killback or dieback on the Firs or any other plants of this Krummholz. Where trees start to grow upward (in the rock-shadow of the strongest winds) they show excellent growth. There are Fir seedlings of all sizes and ages. An occasional Paper Birch (locally considered to be B. cordifolius , will show evidence of hare-browsing above what might have been winter snowdrifts. If such hare-browsing is continued for several years, it is possible that the Firs would overtop the birches, killing them out, possibly leading to differential change in Basal Areas of these species, were they in sample-plot data. An occasional Mountain Ash appears in good health. Shrubs and herbs show no evidence of what today is called "disturbance", "decline" or "stress". It is not known whether this Vegetation Belt is also above the critical acidified fog and cloud area; but in any event, there is no apparent evidence, as yet, of such deterioration as might be credited to acid precipitation.

The Fir Belt. As one proceeds downward from the summit of Camel's Hump, the forest is predominantly Fir, with a small amount of Mountain Ash in the understory, and a few hare-browsed Paper Birch in the gaps (where they might be crowded out by future overtopping by adjacent Firs). It is a considerable distance lower that one first finds Red Spruce; Siccama and those who followed him do not separate the Fir Belt from the Spruce-Fir Belt in their data and analysis (tho their data support the segregation). In my opinion, there is ample reason for recognizing a Fir Belt, lying above a Spruce-Fir Belt, with essentially the same tree-shrub-herb flora and related vegetational potentialities, but possibly with significantly different relations to acid precipitation.

In slope and substratum this Belt on Camel's Hump is not that of the normal thick-soiled gentle gradients of the zonal Mid-Slope. It is very steep, thin-soiled, rocky, and thus approaches the site-situation of a Summit or Crest, or of a lower Rocky Outcrop such as is commonly observed to be covered with conifers, as seen from the

open Summit of Camel's Hump (altho such Rocky Outcrops do not show from a distance any of the Camel's Hump decimation that has been linked to acid precipitation.)

It is our opinion that this Fir Belt is best interpreted and investigated as an expression of local topography, of the "Upper Slope" of its general Vegetation Zone and of its Mid-Slope plant-communities. This conceptualization does not invalidate the thought that it may also bear interesting and significant relationships to a Mid-Slope Vegetation farther north; but it does invalidate any mathematical meaningfulness of a rigid Altitudinal Determinism -- as every observing hiker can see for himself.

Budworm damage can be extreme farther north, but no recent evidence is apparent here. It is perhaps unjust to talk of budworm damage in the same breath as that of extreme acid deposition. This, for the mind of the listener, can be a kind of "guilt by association", but linked no more than two diseases among men, each of which of course does weaken the body with respect to still other diseases.

In the course of a thousand years, it can be assumed that at some time (but not at others), multiple windthrows, single topped trees, and dead standing trees, have made the forest heterogeneous (and thus misleading material for mindless sampling).

At other times however, fires, natural Indian or European, especially those following lumbering at lower elevations, can be expected to have swept up the slopes as fires always sweep up slopes, crowning especially in conifers. On Camel's Hump there is talk about a fire in 1903. Until historical information is unearthed, this tale must be treated with extreme caution, for it could have been a ground fire, or a crown fire, in any of several of the Vegetation Belts. At Camel's Hump, in this and the Spruce-Fir Belt (below), the author strongly suggests that the conifer forests of the 30s could have been essentially even-aged, with very little shrubby and herbaceous understory, and thus now ripe for "decline" (abetted by acid precipitation) with rapid invasion of shrubs, herbs and ferns -- a circumstance that could be most misleadingly described by a forester's sample-plot-data based on trees alone.

Today this Fir Forest is in the area of "dramatic forest kill", dominated by standing, tipped, and fallen gray trunks (widely publicized by stunning photographs). How much of this total "dramatic kill" is Fir Belt, and not Spruce-Fir Belt, is difficult to tell without more information on the dead and down trees -- perhaps 30% of the total. How many of the Firs may have had late slow growth is not known(since dead trees are not cross-sectioned or cored). Besides, all old trees slow down in growth. With the opening of what had been a dense forest, shrubs, herbs and ferns have obviously greatly increased, making the abundant reestablishment of trees (Firs, Birch, and Mountain Ash) relatively difficult, yet probably "natural".

With respect to acid precipitation: healthy young Firs are common in the understory, and show no kill-back effects, such as observed below on the Spruce. Birches are hare-browsed above the snow lines, and put at a disadvantage with respect to fir-competition. Whether young Firs in this Belt are critically slow-growing in Basal Area is not yet known. Shrubs and forbs appear healthy. Sample plot data (1965, 1979, 1983) with respect to Density, Basal Area, and Importance of larger trees would certainly show quantitative "declines" --as it would for over-aged forest subject to natural conditions, whereas seedling counts (and what is a "seedling"? for centuries-old resprouting or layering hardwoods) in the face of shrub-forb exuberant growth, needs very careful interpretation of competition and allelopathy. The above statements do not deny that Acid Precipitation in this cloud belt (which cloud belt may have a significant "top" as a "bottom") may not be an accumulating and menacing factor, revealed in chemical and physical analyses of the air, plant, soil and stream --but only that unquantifiable natural phenomena of the present and past must also be considered.

The Spruce-Fir Belt. Below the Fir Forest, and above a Spruce-Fir-Northern-Hardwoods Forest (see below) lies a Spruce-Fir Belt, with some Paper Birch, that is and/or was dominated by Red Spruce and Balsam Fir (2800-3500 ft.). The upper part, in its very steep and rocky nature, is in all respects an Upper Slope type, as described for the Fir Belt above. The smaller lower part (based on the U.S.G.S. topographic map) is essentially Mid-Slope. For purposes of classification, one can take his choice as to whether to recognize this particular example as part of a colder more northern Spruce-Fir Zone, or as an Upper Slope within the Spruce-Fir-Northern Hardwoods Zone. The author chooses the former. In either case, it is entirely within the "non-logged" "virgin" characteristics as mentioned for the Fir Belt above, with the major exception that it contained and contains a large amount of Red Spruce.

Under totally natural conditions thru the centuries, this forest would be subject to periodic catastrophes, such as ground fires coming up from below and crowning amongst the conifers. (And who would go up to see, much less write a report on the subject? There was no timber to log there.) It would also be subject to periodic blowdowns, and subsequent even-aged reproduction. The normal life of Red Spruce is 200 years or more. Several years ago, this Spruce-Fir Forest was reported as alive and healthy, the needle-loaded branches hiding the views of the distant hills, and the ground below covered with needles, essentially bare of shrubs and herbs (as is apparently true of many old spruce forests all over the world.) Today the majority of the trees, both spruces and firs, are dead; the view to the distant hills is obvious; the understory is newly filled with Hobblebush, Spinulose Shield Fern and other plants (vastly increasing the "diversity"), with healthy young firs, and with young spruces usually showing a kind of recent killback.

The understory trees and shrubs of this forest, becoming more abundant because of recent tree deaths, are: Ribes glandulos , Mountain Ash, Hobblebush, Mountain Maple, Rubus canadensis , Vaccinium angustifolium . The herbs and ferns of the forest, also becoming more abundant, and appearing to some degree to be deterrents to tree invasion are: Dryopteris spinulosa , Oxalis montana , Lycopodium lucidulum , Aster acuminatus , Solidago macrophylla . These herbs and shrubs have not been adequately studied in the past, as part of the total plant-community.

This Belt, above the 3000-ft. break-in-topography, is the lower part of the dramatic death and destruction as seen from the summit of Camel's Hump. Further studies are needed to determine how much of this deterioration was Fir Belt, how much was Spruce-Fir Belt, and to what degree the selective spruce death has resulted in a lowering of the lower level of the Fir Belt! It will take judgment and interpretation to consider how much (but certainly not all) of this decimation is "natural", possibly related to historic fires coming up from below, from windthrows, from normal deaths of individual trees and from general death due to normal break-up of an overaged even-aged stand. These factors, being not readily quantified, have been neglected in the Camel's arena.

With respect to acid precipitation: Red Spruce is known to be highly sensitive to this aspect of atmospheric pollution. This forest is dominantly Red Spruce, with lesser amounts of Fir. The local highrise topography receives the full impact of clouds from the west, combed of their moisture by the evergreen foliage. The death of the forest is indubitably alarming. But it must be remembered that this combination of events is a statistical geographical abnormality, and occurs (I judge) in 5% or less of the spruce-fir forests of the northeast. Other spruce-fir forests predominate on Mid-Slopes in northern New England, and do not now show such dramatic kill. In our opinion, there are two, possibly distinct, elements of the air pollution problem.

Firstly, any hiker on the trail can observe the cross-sections of recently cut logs, of recently dead trees that had fallen across the trail. One recognizes normal variations such as a period of very slow growth while the tree was in the understory and shaded, and variations in growth along different radii (reflecting differential growth of leaning trees, common on thin soils overlying rock). One quickly notices that most trees show a remarkable slowdown, and then a continued slow growth, beginning 20-30 years ago! If this phenomenon is widespread in other and low-elevation forests, the country has a silvicultural problem of prime importance, even tho it may not be correlated with tree-death at any one time, as of this forest. A comparable slow-down has been recognized in sugar maple in northern New England that may be causationally linked.

One should insert here the scientific superiority of viewing entire cross-sections of trees, over the taking of single cores. The entire cross-section shows that the original pith may not be in the geometric center, and that the growth rates can vary markedly along different radii (in part related to strains and stresses of leaning trees). Cores can only be considered as "samples" from the total trees, taken "at random" by internes and technicians not necessarily familiar with this variation, and possibly choosing the side that is most comfortable for the coring. Thus, the final impressive ecolometric data may have more inherent biases and prejudices than appear at first glance.

Secondly, is that element of the air-pollution problem revealed in a constant characteristic of the young spruces up to 15 feet in height (but not seen in the large trees in the forest, tho looked for). In June 1984 it was obvious that many of the 1983 needles were yellowing, altho the 1983 needles were apparently growing normally. In July 1984, the 1983 needles had died and were rusty red, tho the 1984 needles were normal. This pathologic effect was usually limited to the upper branches of saplings (to 20 feet in height) in the forest. There was usually no such effect on the lower branches of the same trees. Furthermore, there was constant evidence that such a dieback had also occurred in the past, perhaps 4 or 5 years before, with perhaps even earlier such events. In short, the tree was not being "killed" (as possibly it is by 30 years of slowdown); but its upward growth was restricted. One is led to the very reasonable hypothesis, as developed by the Camel's Hump group, that acid water fogs and snows, impinging on the conifer forest, accumulate acidity. Then a sudden early spring thaw and/or rain washed the entire load onto the understory vegetation (but not on the still-snow-covered lowermost material) to produce this pulsational contact-kill-and-burn, in turn affecting the future forest.

With respect to Fir of this Belt, and all the hardwoods, no such kill-observations were obvious or recognizable. On the other hand, the increase of shrubs, herbs and ferns (and in recognition of the impact of hare-browsing) would have unsettling effects on quantitative "seedling"-count studies. In other words, numerical decrease in Density, Basal Area, and Importance, and sapling numbers, may not be due directly to acid precipitation effects, but in greater or lesser part to natural changes following the natural loss from which a new forest will emerge in 80 years or more. This viewpoint does not belittle the short-term and long-term importance of acid precipitation at the chemical and physical levels of air, plants, water and soils of acid-killed Spruce, of short lived Fir, but only that many other parameters (not quantifiable) of the changing tree-shrub-herb plant communities must be better recognized.

The Spruce-Fir-Northern Hardwoods Zone. As one descends the West Trail, from an elevation of about 2800 feet (850 m.), beech sugar

maple, yellow birch become more and more abundant. At the same time, Fir becomes less abundant; Spruce occurs farther down, and occasionally a Hemlock is seen. For reasons not overly evident on this single transect-trail (but as related to the general situation in Vermont and the entire Northeast), this stretch is now placed in the Spruce-Fir Northern Hardwoods Zone. (Siccama called this zone the Transitional, a term entirely suitable for those who like to believe in a northern evergreen coniferous forest, a southern deciduous hardwood forest, and a "transition" between them, a heritage from Weaver and Clements, who did not know the East and assigned its mapping to a now-unknown third party, fide Marston Bates.)

On the Trail, there is an upper part which peaks at 2900 feet (just east of Bald Hill which peaks at 3200 feet), in which the hardwood trees are shorter, more limby, the land surface steep, the soil thin, over rocks, and having the characteristics approaching the concept of "steep upper slopes" as mentioned above. Below this level, the entire Zone is deeper-soiled, with more gentle gradients. To this complex, we must add the differentiating historic effects of selective lumbering, and of fires. Lumbering practices, from the 1800's to 1920, are known to have taken out Spruce, leaving a "northern hardwood forest" Cover Type (now a very fashionable term). In addition, the possibly frequent fires of those post-lumbering days would have resulted in selective elimination of fire-sensitive Spruce as well as of Fir. The resulting "northern hardwood" Cover Type (governing much of our contemporary thinking) is a forest that potentially could have much Spruce and Fir in old pastures, Hemlock especially in the ravines of the lower Beech-Birch-Maple-Hemlock Zone, much Spruce and Fir on the rocky outcrops and by new invasion into the understory of this Spruce-Fir-Northern Hardwoods Zone. One should also mention all the Beech-Maple "northern hardwoods" southwards and in the Midwest. The term "northern hardwoods" can be unfortunate in its meaningless multizonal inclusiveness.

In this part of the Green Mountains, this Zone presumably includes also all the lower areas (as seen from the 4083-ft. summit, in early summer when in new foliage, that then look as green as a lawn in contrast to the spires of conifers on the steeper and rocky slopes at various elevations. It also appears that much of this forest is below the cloud and fog belt. It then shows none of the decimation that affects the terrain from 3845 ft. (the saddle just north of the Hump) down to 3000 ft. (910 m.), which is the "break in topography" from steep Upper Slope to gentler Midslope. There are occasional large older trees that appear decadent, as is to be expected in any "over-aged" forest. The deer population does not appear to be excessive, as evidenced by the relatively lush growth of Hobblebush.

The trees of this forest, in order of abundance, are Yellow Birch, Spruce, Fir, Mountain Maple, Beech (any numerical "decline"

of which must evaluate the role of the decimating Beech Bark Disease), with understory trees being Striped Maple, Mountain Ash, Pin Cherry.

The shrubs of this forest include Hobble Bush, Raspberry, Hazel Nut, Ribes glandulosum , Rubus canadensis , Rubus pubescens .

The herbs and ferns of this forest include Lycopodium lucidulum , Dryopteris spinulosa, Aster acuminatus , Oxalis montana , Trillium erectum), Solidago macrophylla, and many others.

Natural developments in this Spruce-Fir-Northern Hardwoods Zone would, in my opinion, tend towards a slow increase of non-sprouting Spruce and Fir, and a relative decrease of the resprouting hardwoods -- in the absence of selective lumbering and the early fires that had probably occurred thru the past 200-400 years. Since these relatively high lands have not been significantly grazed (the farms are concentrated in the lower valleys) there is not the complication of heavy invasion of species unpalatable to cattle, which for this Zone happen to be Spruce and Fir. Fifty years ago those conifers are recollected as frequently forming a coniferous belt (upper old pastures) along the west side of the Green Mts., above the open farm pastures, and below the de-spruced hardwoods of this same Zone.

With respect to acid rain: (1) scientific evidence from Camel's Hump researchers is pointing towards a significant correlation of late-winter thaws releasing acidity from winter snow accumulations on upper branches of tall conifers (not a fog-belt phenomenon) on to above-snow spruce saplings, resulting in their killback in certain recent years. If this phenomenon continued (at sporadic intervals thru the years) it would clearly diminish the role of Red Spruce in the understory and in the future succeeding forest -- as long as there are some Spruces and Firs in the overstory to collect out these acid-snow materials during the winter.

(2) Data for a 20-30 year slowdown in growth of all Hump trees, both conifers and hardwoods, are not yet convincingly available, altho it is suspected. Such a slowdown can never be told from the biomass tree data alone. The unlumberedCamel's Hump forests of this Zone, now in a State Park, were obviously reaching "maturity", and unfortunately we have had no interest in or estimate of, the natural change of biomass, associated with natural deaths of what Egler considers an essentially even-aged post-catastrophe forest-community, in which individual trees would now be dying from "natural" causes, and replaced by other elements of the plant-community, including shrubs and herbs which tend to retard the re-invasion of trees (despite Clementsian dogma). Deer do not seem abundant enough to influence the reforestation (tho they are so, elsewhere in the Northeast), and the fire-frequency has certainly changed in this century, as to short-term and long-term effects on the total Vegetation. In general, aside from the pulsational damage on Red Spruce saplings, the growth of all trees (except large Spruce

probably), shrubs, and herbs in this Zone, in my opinion, appears healthy and "normal". Basal Area, Biomass, Density, Importance, and sapling data (all tree data,remember), tho showing numerical declines, can be given in part other than acid-precipitation-caused interpretations (involving the entire community of trees-shrubs-herbs). One needs more detailed information on the deaths of large spruce in this Spruce-Fir-Northern Hardwoods Zone (separate from the dramatic decimation in the Spruce-Fir areas at higher elevations). These statements -- in no manner whatsoever -- are in conflict with the alarming increase and worsening of chemical and physical details in the environment, and the holistic, integrated, synergistic viewpoints of certain sound environmental scientists: that atmospheric pollution must quickly be brought under adequate control.

Beech-Birch-Maple-Hemlock Zone. As one descends the Trail, now entirely of Mid-Slope condition, at about 2400 feet (730 m.) Spruce and Fir have completely dropped out, and Hemlock starts to appear. (This is the bottom of Siccama's "Transitional Zone," but significantly it is also where the Trail first crosses a major brook -- yet one more topographic phenomenon that plays no conceptual role in the hypotheses of Altitudinal Gradients and Direct Gradient Analysis.) The Trail now descends gradually, and ends at 1800 feet (550 m.) From that upper 2400 ft. point, far down to, and for many miles along the Huntington River, the Vegetation is that generally known as Beech-(Yellow) Birch- (Sugar) Maple-Hemlock Zone, with White Pine as the chief pasture tree. Perhaps related to past lumbering, native herbivores, and fire, Hemlock is not conspicuous. The result: another local Cover Type of "Northern Hardwoods", a satisfactory term for practical lumbering silviculturists. I prefer to place this Zone in the Taiga region, since the vegetationally significant species are those of Transeau's Great-Lakes-St. Lawrence Taiga Center.

This section of the Camel's Hump Trail is typically very variable and patchy as to the local occurrence of its predominant trees, which have common heights of 80 feet and diameters of 12-24 inches. In order of abundance, they are: Sugar Maple, Beech (heavily affected by the Beech Bark Disease, which however seems only to stimulate rootsuckering and thus can enormously increase "sapling" counts), Yellow Birch, Mountain Maple and Striped Maple. Hemlock is here localized in the forested stream valleys. White Pine is locally rare (tho it is abundant thru the farming areas of the Huntington River at 500-700 ft. elevation).

The following shrubs also occur, in order of abundance: Hobblebush, Red-berried Elder, Alternative-leaved Dogwood, Rubus pubescens, Raspberry, Lonicera canadensis, Yew (indicating lack of deer), Ribes triste.

Ferns and forbs are numerous, including all those mentioned for the Zone above, plus many more, but a few, like Dicentra, come from the more austral deciduous forests.

The Vegetation of this Zone (the "Deciduous Forest" of Siccama, despite the actual and potential importance of conifers in it, is so-called in physiognomic contrast to the "conifer" belts above it.) Hemlock significantly occurs along streams, and can become locally abundant elsewhere in the Zone, on pastures (where it is not eaten), and on rocky outdrops (where inter alia, fire has not reached), on shady roadsides (where bare soil has occurred) and along streamsides. Enough time has passed since last lumbering for individual old trees to die standing, to snap off, to be tipped over, leaving the gap to be filled by the coincidental understory trees, and/or by shrubs and ferns that might themselves restrict reforestation. Under these circumstances, one can expect certain mathematical parameters such as tree Density, Basal Area, Biomass, Importance, and sapling numbers to vary markedly from decade to decade, all within the natural fluctuations of forest behavior and/or other factors.

As with the Zone above, we found no eye-apparent and obvious kill or damage on trees, shrubs or herbs, as might be related to acid precipitation. Again, this situation has not been investigated with respect to long-term slowdown of radial tree growth. (Public interest is understandably centered on the obviously decimated high-elevation Spruce forests). Such longterm slowdowns could easily be observed in this Zone on areas recently lumbered, tho such research may seem too cheap and easy. Continued atmospheric pollution will unquestionably alter the details and equilibria of forests -- until as every lay holist knows (scientists rarely grasp holism, laymen do), there is the proverbial straw that breaks a camel's hump.

II. Highway Reconnaissance in the Green Mt. Area

The conceptualization and implementation of the subject of Vegetation Zonation in New England has interested me since my field work of 1934-36 (Egler 1940). The theory is essentially the same as that of Bray 1915 for New York state; and work had been progressing for a refinement of the New York state Zones during the late 1930s (never finished). In addition, I have applied the theory to other areas of New England and to various other parts of the world.

With respect to this preliminary study: Norfolk, Conn. lies approximately 150 miles due south of Camel's Hump. In the two automobile trips between these places, approximately 500 miles were covered, including both east and west flanks of the Green Mts. (and their continuation southward as the Berkshire Plateau, plus several traverses across the Green Mts. and loops out to Lake Champlain. The route wove in and out of the Spruce-Fir-Northern Hardwoods Zone (with Spruce and Red Pine on rocky outcrops and summits), and the Beech-Birch-Maple-Hemlock Zone, with White Pine in old pastures

(and White Pine and Hemlock on rocky outcrops). At the lowermost elevations near Lake Champlain, a lower austral Zone occurred, with scattered oaks, hickories, Pitch Pine, and Red-cedar in the pastures, such as found also in the Hudson River and Connecticut River valleys, and in southern Connecticut.

The specific objective of this reconnaissance is related to widespread statements and frightening implications in the popular and journalistic literature, the conservation literature, and even in some of the scientific literature, that decimation and destruction of forests due to acid rain is "common" and "widespread".

In summation of this preliminary reconnaissance -- limited as it was geographically and to areas visible from highways: It may be said (a) that no such near-total dramatic destruction of Spruce and of spruce forests was observed, as that which occurs in a headband-like ring around the bald summit of Camel's Hump. Furthermore, no obvious stress effects were noted on White Pine, or on Red-Cedar, or on any of the hardwood stands in any of the three Zones. Furthermore (b) with respect to Red Spruce trees, no lower-level branch-tip killback was ever noticed, such as might occur from a sudden heavy deposit of atmospheric pollution as in a thaw of late winter, after snows were retained in upper branches.

In these statements, the reader must not construe the idea that no cumulative deleterious effects of atmospheric pollution are having their critical effects -- only that no visual effects were then observed in this part of the Green Mountains, such as are said to "occur widely in the Northeast". One must remember also that on high rocky thin-soiled summits, a natural slowdown is likely to occur as the trees, and their evaporating surfaces, become larger and larger, depleting sooner the summer soil-water supply, a supply that may not be changing. Heavy drinkers exhaust a limited supply more quickly than light drinkers.

III. Annotations on Selected Literature

Acid Deposition Research Project. 1984. Research on Acid Deposition in Terrestrial Ecosystems. ca.258 unnumbered pages. Unpublished, Botany Dept., Univ. of Vt., Burlington 05405.

This is an unpublished collection (no Table of Contents) of published papers, papers in press, and draft manuscripts of completed or nearly completed investigations, including a list of 12 studies in progress.

Here is an excellent collection of information from this leading center of acid deposition research, with field work located primarily on Camel's Hump, a relatively isolated peak of the Green Mountains of Vermont. Among the researchers are: Margaret Bliss, Richard M. Klein, Tim Scherbatskoy, Thomas G. Siccama, and Hubert W.

Vogelmann.

This group has centered its activities on the west side of the mountain, available only by foot trail, extending from a Beech-Birch-Maple-Hemlock-White Pine Zone , thru the Spruce-Fir-Northern Hardwoods Zone, into a Spruce-Fir Belt, a Fir Belt, a Fir Krummholz, and a tundra-like rocky summit. There is no question to all scientists and visitors that the mature Spruce and even the Fir Belt, shows not a mere "decline", but a striking deterioration,with 80% or more kill (1984) of the largest trees that can only be called a devastation. Sound scientific studies revolve around ecolometric analysis of quantifiable parts of the ecosystems in the field and in the labo-tory, including reasonable scientific controls. As is true of most such parts-studies, they have not found one-factor "causes", and thus see the need for "further research". Past studies are not whole-studies.

The Vermont group looks upon this local devastation as harbingers of worse to come, and of adequate evidence calling for social action quickly to curb the amount of interstate and international atmospher-ic pollution, regardless of local job displacements and economic costs to certain industries. Unfortunately, they too often expose themselves to criticism from their scientific ecolometric parts-analysts, by quick and sudden extrapolations. For example, in ad-jacent sentences, and in the same paragraph, one often reads of the dramatic kill of one Spruce stand on one high-elevation rocky-slope mountain, leading into a general statement that all spruce forests, in all northern New England, are under "stress" and "decline". Or one cannot tell whether the original statement pertained to one acre or ten thousand acres. When such extrapolations are grabbed out of context by conservation groups and the general media, they can do great damage in a social context. A deficit of another dimension, inherent in all quantitative ecology, is that what cannot be quanti-fied, or has not been quantified, "does not exist". And thus, statements of a "decline" in certain tree species may possibly be due, not to continued acidic deposition, but simply to unmeasured or unknown "natural" factors in the unknown life of the whole forest. This problem is not unique to the Camel's Hump group, but remains unresolved amongst those scientists who cannot rise above their quantified parts-methodologies.

Boyle, Robert H. and R. Alexander Boyle. 1983. Acid Rain. 146 p. New York: Schocken Books. $14.95.

In a social issue of the importance of acid deposition, many aspects of human society become involved, each with its limitations, weaknesses and advantages. Certain scientists are no saints when it comes to communicating with other scientists. The conservation-ists can easily have too few facts with too much emotion (as with the anti-all-pesticide issues). Industry has a quarterly profit to show, and does not hesitate to utilize OPECoid oligopoly tactics.

The economists have their own worshipped quantified indicators and resultant forecasts. The communications media have spawned a dozen special breeds of the race. Thru television, radio, newspapers and magazines, the media reach the greatest numbers of people, in language and images they understand. The successful writer is a powerful force in our society.

The writers of this popular non-technical book are a father-son team. Robert H., father, is a senior writer for Sports Illustrated. The son is graduating from Trinity College, Hartford, in 1985. Together, they have written a short, but highly effective survey of the subject. Ecologists may not be satisfied, for ecologists restrict themselves to "analysis" (breaking down into parts), experimentation, "controlled conditions", sampling, all limited to "rigor" and "elegance". Conservationists may not be satisfied, for there is no attempt here to whip the public into a frenzy of letter-writing, lobbying, legislation, law-enforcement and litigation. Yet I dare say, that this book will influence, and influence with advantage, a large group of people otherwise unreached.

The informal bibliography at the end is impressive for its wide coverage on the international scene, and within the various segments of society. The book packs much within a relatively few pages.

The volume is divided into several logical chapters: Scope of the Problem, Slow-Motion Destruction, Damaged Waters, Other Effects (crops and forests), The Politicians Stall, Industry Arguments, and The Solution. Without coming forth with some Utopian prayer, they say bluntly "but I can tell you this: this message on the deep desire on the part of the American people to battle pollution is one of the most overwhelming and clearest we have ever recorded in our 25 years of surveying public opinion." A layman can make but one suggestion: Since "the EPA calculates that before 1970 there were only two stacks more than 500 feet high (p. 19) in the United States. Now there are 180 such stacks": one could recommend that all the high stacks, or only one stack, be pulled down. If the change does not ameliorate the acid deposition problem in the downwind areas, and if the Ohio Basin, unscrubbed and low-stacked, does not yelp in polluted complaint, the major question will soon be answered. But I am sure such a question will never be considered - it is too "unscientific", too alien to eco-logical thinking, too disruptive of job-securities, and politically too inflammatory.

Burgess, Robert L., Ed. 1984. Effects of acidic deposition on forest ecosystems in the northeastern United States: an evaluation of current evidence. 108 p. (including bibl. of 20 p.), plus 10 t. and 22 f. SUNY College of Environmental Science and Forest., Inst. of Environmental Program Affairs, Syracuse, N.Y., 13210.

Here is an enormously valuable document, analyzing, summarizing and systhesizing existing scientific information on acidic deposition, as related to northeastern forest ecosystems. Dr. Burgess

was more than Editor; he wrote many of the evaluations. He organized the material in a masterful way as shown by the topics selected, and their organization in the Table of Contents. His abstracts and evaluations represent contemporary ecolometric thinking at their pinnacle, entirely free of emotional and inconsistent judgmental extrapolations. The volume was prepared by contract, the contractor asking five questions (pages 4-5) which five were answered (pages 82-87).

At the same time, this volume is the best expression of which I know, in print, which brings into the sharpest of focuses the conceptualizations, the methodologies, and philosophy of contemporary mathematically-oriented ecolometrics, its advantages and disadvantages, its limitations and restrictions when operating in connection with the socio-economic realities of governments, politics, industry, management and labor, whose short-term decision-making judgments are direct, absolute, definitive, and allow for no elasticity and uncertainty.

Readers will note the emphases on "experimental designs" (part of one's laboratory training), of "causes and effects" and "interrelationships" (part of ecology's limited non-holistic philosophic heritage), or "sampling" (an assumption of statistical theory, made more awkward by the field man's growing recognition of such as "patches" and "gaps" in space, and catastrophes and disturbances in time), and of mathematical modeling (based on an intellectual activity, mathematics, which is not a "natural science" and which, by its language, its numeracy, ignores the unquantifiable and the immeasurable, as even Pythagoras knew).

One will also note the frequent and significant use of such words as "alleged", "purported", "reportedly", "may", "can", "attributed to", "has been implicated as". The limitations of ecolometrics are recognized: "conclusions ... must be viewed with caution ... such experiments may not accurately simulate natural processes." Such logical uncertainties are at the root of Burgess' numerous non-concluding conclusions, such as "In summary, no direct or indirect effects of influences on productivity have been linked to trace metal accumulations in the Northeastern U.S. with the exception of areas very close to point sources." "No documented link to red spruce decline, nor to other species in the Northeast," "Some consequences of increased acidic deposition...can be predicted. However, we do not know how long it may take to produce significant effects." "No sufficiently complete studies on any northeastern tree species are available; hence any suggestion than an Al problem may or may not exist is premature." "It is not possible at present to determine whether these growth declines are related directly, indirectly, or are unrelated to acidic deposition." "Stem disks...to determine ring widths give no unambiguous evidence of the influence of extrinsic environmental variables." On the damage levels "of Germany. It should be emphasized, however, that these data represent

a qualitative assessment of dieback in trees, not a quantitative measurement of injury." "Both the North American and German mortality problems at the present time lack obvious causes." On "concentrations of heavy metals...The impact of this type of change on the plants or on the soil microorganisms has not been determined." "How fast natural podzolization is increased by inputs of acid is not well understood." In the conclusions, "Alleged impacts of acidic deposition on forests generally include one or more of the following eight mechanisms, processes, or events...None of the eight... can be individually unequivocally, or directly tied to the apparent "dieback" of red spruce and/or other species in northeastern America." The volume closes with the words "Numerous research projects are currently contributing toward resolution of critical questions relating acidic deposition and forest ecosystem vitality. It is anticipated that new research findings concerning the influences of acidic deposition on soils and vegetation will provide clarification of the role of atmospheric deposition in forest dieback." On this philosophy another could say: Let us do nothing, after all these millions of dollars for research; but let us use up more funds, for more research, to take more time; then we may know within the philosophy and methodology of contemporary mathematical and statistical ecolometrics, one can be in entire agreement with these conclusions, for such conclusions are inherent, are part and parcel of this "way of science". Egler is reminded of the DDT hearings in the Mid-West twenty years ago. He was told that one of the nation's most eminent researchers had proved a flop on the witness stand - altho to other scientists there the evidence was overwhelming as to the adverse effects of DDT on the whole ecosystem. This scientist just would not commit himself to any direct, absolute, irrefutable "effects" on any part of the ecosystem, as "caused" by DDT. I was jokingly told that he would not even claim that the sun would rise on the morrow; it was highly "probable", but not 100% sure.

Egler feels obligated to add that his own, purely personal viewpoint, is that Ecosystem Analysis, a breaking down into parts, and a study of those parts and the interrelationships between them, will never solve the problem that now lies before humanity with respect to atmospheric pollution. I would not discourage the admirable knowledge we are gaining with respect to those "parts".

The situation is directly comparable to the elemental chemist who might wish to understand water, H_2O, by studying elemental hydrogen, and oxygen, and their reactions to each other, but not studying the molecules of water, because he has no methods by which to study molecules. The intellectually superior emergent evolutionists and the holists of years ago would have smiled in sadness. True, there is as yet, no adequate holistic Ecosystem Science. We need scientists (as Kimball and Levin have so excellently restated, ibid.1985) with a grasp and an assurance who -- even if they do not know the detailed cytology, chemistry and physics --

will still make decisions with regard to whole situations, situations that are indubitably harmful to human society. If you fall into a cesspool, you don't set up a research program to analyze the parts and components. You climb out, and clean up.

Linthurst, Rick A. 1984. Direct and Indirect Effects of Acidic Deposition on Vegetation. 117 p. (Volume 5 of the 9-volume Acid Precipitation Series). Boston, London et al.: Butterworth Publishers. $32.50.

This hardback book ($250.00 for the series of nine) is a valuable source of information, even tho -- in this rapidly advancing field -- it will be out of date in a year or two.

There is a generalized 2½ page introduction, in which the Editor states that "To date, few studies exist that support beliefs that long-term acidic deposition will negatively impact plant productivity. However, logic dictates that two plants, or two plant systems, exposed to different levels of sulfur, nitrogen and/or hydrogen ion will differ in their response." Later, "Current data are not sufficiently convincing to support the hypothesis that acidic deposition has affected the growth of any important tree species. However, these data are sparse and a major effort is underway to determine if changes in forest productivity have occurred over the past fifty years." (A nation-wide set of stump photographs by loggers currently operating, and another set of photographs by Sierra Club hikers who are clearing trails from fallen trees, would provide indicative information if scientists would condescend to utilize such untrained labor.) Later, "Recent evidence suggests that the structure and function of high elevation forest communities have been altered." The word "suggests" plainly shows that the author has never climbed Camel's Hump). But he continues "Acidic deposition and 'acidic fog' may, in part, be responsible for these observations." (He is generous, in the narrowness of his ecolometric philosophy of parts, not wholes.)

This volume contains 8 chapters by twenty recognized scientists. Richard M. Klein opens the first chapter, "Ecosystems Approach to the Acid Rain Problem" with some super-pregnant statements: "As one who has spent his entire scientific life measuring to the third decimal place, it was difficult to accept the fact that two areas on the forest floor separated by 10 cm. could be entirely different ... Cause and effect are not directly related, and the totality is certainly different from the sum of its parts." (So what is new?) If those concepts were really integrated into the thinking of the ecolometric establishment, the rest of this book would have been vastly different.

I find it most interesting that in the seven other chapters, in each one without exception, the authors end with blunt undeniable statements of uncertainty: "Suggestions", "modest evidence", "con-

tinued investigation...essential", "additional studies...needed", "no conclusions...are warranted", "effects... may never be found, (other) methods will be needed." If we integrate these statements of authorities, we can understand how the White House rationally takes the stand that there should be no political action "without more research" (without which research, many of the jobs of many researchers would be dislocated). The American public may wonder about the role of ecolometricians in critical social issues.

Siccama, Thomas G. 1974. Vegetation, soil, and climate on the Green Mountains of Vermont. Ecol. Monogr. 44:325-349.

The parameters of this study are succinctly stated in the second paragraph of the Introduction: "The objectives of this paper are (1) to describe the composition of forest stands along the altitudinal gradient on the Green Mountains (actually along a public foot trail) and (2) to study the changes in climatic and edaphic factors along the altitudinal gradient and interpret them in relation to plant community distribution." Within these objectives Siccama carried through intensive and rewarding data-gathering. For three years (1964, 1965 and 1966) he weekly climbed, summer and winter, the Trail on the west slope of Camel's Hump. He visited and studied to a lesser extent the forests on three other high summits. He now owns a home at the end of the Town Road and at the base of this mountain trail. This paper is the most-oft-quoted and lavishly praised study in the entire Camel's Hump literature, and is widely recognized as the root, the foundation, of subsequent Camel's Hump research, and thus of current views that Camel's Hump provides: a "longterm ecological data base, unmatched for mountains of the northeast U.S.", "the best data base in North America...less than twenty years old", "our field data base is probably the best in North America, but it extends back only to 1965", "we have the oldest forest inventory and ecological survey base for high elevations in North America".

The philosophic approach used in the study was strictly methodologic, one of Direct Gradient Analysis (Whittaker 1967). Plots and transects were located at 11 points from base to summit, at 200 foot differences in elevation (always stated however in meters, so that every reader using the U.S.G.S. topographic map has to translate from current scientese back to the language of the map). Plant-community data are manipulated to provide Basal Area and Density data, combined as Relative Importance Value. Trees,shrubs and (most) herbs are reported in terms of Frequency, and Cover Percentage. All standard soil tests were made; and climatic studies were with the instruments of the time. (Subsequent studies have been made: "Special care was taken to sample the forests in the same manner as was done in 1965 and 1979. One person (Bliss) was trained by the original investigator (Siccama) and was involved in these studies of 1979 and 1983.") The new studies have provided comparative tree data on Density, Basal Area, Biomass, and seedling

counts, and these manipulated data reveal very high mortality and "declines" in all tree species, coniferous and deciduous, at all elevations. Numbers do not lie.

It is extremely important to evaluate the conceptualization, methodology and philosophy of Siccama's study: He draws a major and fundamental distinction between the Eastern Deciduous Forest, and the Boreal (primarily coniferous) Forest, here called "Montane". This is a physiognomic distinction related to the ancestral evaluation of the major tree species, helped to eminence by Weaver and Clements, and later by Lucy Braun. More specifically, Siccama established himself as a disciple of Whittaker, and of his altitudinal gradients, ordination, and Direct Gradient Analysis, as first developed in Whittaker's doctoral thesis from studies in the Great Smoky Mountains. Direct Gradient Analysis infers that plant-community characteristics of compositon and structure (wrongly but conventionally called "phytosociological", from a misunderstanding of the Braun-Blanquet literature), are "directly" and meaningfully correlated with that admirable mathematical gradient of elevation. This is one aspect of the Environmental Determinism which underlies much ecological thinking. Since Whittaker first asked Egler to comment upon his early manuscripts, I have considered Direct Gradient Analysis too simplistic, even for the Great Smokies. It can be an extremely misleading parameter for evaluating the complex and often paradoxical variations in the plant-community complex. I may live long enough to see the tide turn. There is current interest in patches and gaps, in disturbances and catastrophes, wave regeneration, in blowdowns, dead standing trees, floods, fires, slumps and saddles (but not yet in the Centers of Distribution of Transeau (1905), in the Zones of Bray (1915) and Egler (1940), or in the UpperSlope-MidSlope-LowerSlope-Wetland sequence of the local topography, in which the summit may not be more "boreal" but more austral! All these natural elements make the state of original virginity, of a neo-virginity, or merely of the complexities of ordinary behavior, a far more interesting and challenging piece of natural history to pursue, than the simplistic eco-logical thought of this data-banking and data-manipulating generation.

CONCLUSIONS. In the last ten years, the literature on acid precipitation has become truly voluminous. There are several entire books on the subject. The conservation organizations have comments in almost every issue of their magazines, plus special reports. The news media are highly active, often using frightening titles and illustrations. Scientists have been swept into the issue, at times with philosophic incompetence, costly lectures, time-consuming symposia, and endless expensive research papers. Students have told me that it is "the easiest thing" to get funds for lavish research in the field. Economics, industry, politics, and state and national governments are involved. Clearly, the subject has become

one of the major environmental issues of the day, on the level of overpopulation, limited resources, and general environmental pollution, in turn seeming to become the most costly single expression of the ecolometric Research Establishment. It is my limited intent here to make a few general comments on my field survey, and on the scientific literature which in my opinion has led to epistemologic approaches not always as helpful as they might be within the world of science.

• The scientific research on acid precipitation has been a costly detailed extensive study of parts of the complex synergistic holistic system that IS the heavily polluted atmospher now part of man's and nature's environment.

• Camel's Hump is one of several isolated high-rise statistically-abnormal atypical mountains, rising above the general level of the Green Mts., receiving the full brunt of undeniably pollution-laden winds, clouds, rain, fog and snow as was effectively combed out by the dense gymnosperm forests which were or are at a "mature" stage of development in relation to historical fires, lumbering and windthrows. Therefore they are especially susceptible to the proverbial straw that breaks the Camel's Hump, as to the "decline" or "stress" that affects all old organisms, called senility in man.

• The studied parts are samples, only samples of much larger spatial and temporal wholes. No short-term study will tell us in detail what happened 20 years ago, or can tell us with assurance what will happen 20 years from now.

• Contemporary ecolometric scientists are not always versed in the art of extrapolation from their limited data to larger wholes: from, e.g., their plot samples at certain elevations to the entire Belt or Zone adjacent to it, or to other parts of the same Belt or Zone thruout any one state or larger region.

• Contemporary ecolometric research deals only with the quantifiables. What cannot be quantified does not "exist".

• Methods for the study of "parts" (such as S, N., ozone; Zn, Pb, Cd, Al, Mn) or for certain "processes" (release, solution, binding, in soils) does not study the synergism of wholes. (Extensive study of hydrogen, or of oxygen, cannot substitute for, or predict, the characteristics of water.)

• Black box studies are highly important, but they are no more illuminating of the whole than the neurotic concern of an individual towards the calories and vitamins and roughage of one's food (intake) and the analysis of his elimination (outgo) while overlooking all that happens "inside" the two-holed box.

• One should separate the scientific record involving the possibility of (1) longterm 20-30 yr. slowdown in growth (as revealed to observing hikers by the cross-cut trees that had fallen across the Trail), which can be correlated with long-term slowdown that might be widespread across the Northeast and of great importance to the entire forest industry, and (2) a pulsational intermittent killback from early-spring snowmelts from upper branches, falling on above-snow-drift spruce saplings, that may be extremely local in occurrence.

• The socio-economic realities of short-term data-gathering publish-or-perish intensive research, without the time and thought and ability for extensive studies,is an essential aspect of the picture.

• The greatest missing element in all this scientific picture is a pathetic lack of background and interpretive studies on natural vegetation, natural conditions, and natural areas. This situation is an endemic disease of Vegetation Science in America, despite the early interest of the Ecological Society of America (1917) "to preserve and study such areas." Such lands have been preserved, but very inadequately studied on an integrated holistic basis. When studied, the research projects are focussed on smaller and smaller parts of larger and larger unknown wholes.

• In my opinion, these factors have often led competent scientists to extrapolate, to generalize, to express their sound (but unquantified) judgments and opinions, (and sometimes their emotional fears) in ways that are picked up by the media, by the public, and by the government; and then exaggerated to degrees that polarize the issues and that are harmful to sound ecologic understanding and solutions in the public interest.

• Acid Precipitation was first born as a societal problem, the result of a polluting technology. It caught "ecology" with more than its hair down, totally unfit (read the literature) to handle problems of this conceptual holistic magnitude. It is putting contemporary Ecolometrics to the severest of all possible tests. In the light of the present evidence, the philosophy, the conceptualizations, the methodologies, have been woefully inadequate to the task. The science pins itself to "analysis" into parts, to applied mathematical and statistical methods that could be strongly criticized by mathematicians and statisticians themselves, to a search for single-factor causes, to interrelationships of those parts, to a mechanistic philosophy, and to an environmental determinism, to the nurture side of a nature-nurture argument (Egler, 1975, The Way of Science), priding itself on elegance and rigor - a kind of Physics Envy that today also affects many other fields of science (Lewis Thomas. 1983. Late Night Thoughts: 143-155).

The human brain has always found it especially difficult to conceptualize with wholes larger than itself, even as to human-social wholes. Ecologists are not drawn from the ranks of sociologists (and sociology itself has its problems). The intellectual comprehension of the Holism and the Emergent Evolution of Smuts, Wheeler and others of 50-60 years ago (Egler, 1942) is either dead or denigrated. Ecologists talk about their "ecosystems" with the mind of one who still sees only the species and the individuals. Perhaps the field, now a self-perpetuating homeostatic Establishment, needs a revolution, by a minority of a totally different personality type, who will study wholes first, then parts. The message even of Gleason (1917 et seq.) has been lost.

• And so, the Acid Precipitation problem reveals itself as one not only involving science and especially the eco-logical sciences, but also the very foundations of our government (rooted in Locke and Hume, in Adam Smith, and in aggressive individual liberty), and our citizenry, and the health and welfare of our land. As never before, our eco-logical establishment and its cadre of eco-logical scientists is standing before the judgment of future mankind.

end.